ISSN 1346-7565 Acta Phytotax. Geobot. 54 (2): 87–97 (2003)

Taxonomic Study of Podostemaceae of China

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A taxonomic revision, including a key to the species, synonymy and taxonomic notes, of the three genera and six species Podostemaceae of China is presented. *Terniopsis* (subfamily Tristichoideae) is monotypic, containing only *T. sessilis*. *Cladopus* and *Hydrobryum* (Podostemoideae) are represented by *C. japonicus*, *C. fukienensis* and *C. austrosinensis* (sp. nov.), and *H. griffithii* and *H. japonicum*. *Cladopus chinensis* and *C. austrosatsumensis* are treated as conspecific with *C. japonicus*. *Hydrobryum japonicum* is reported from China for the first time. The family occurs in Fujian, Guangdong (including Hong Kong), Hainan, and Yunnan.

Key words: China, *Cladopus*, *Hydrobryum*, Podostemaceae, taxonomy, *Terniopsis*.

Discovery of the Podostemaceae in Japan by Imamura (1927, 1928*a*, *b*, 1929) and Koidzumi (1927, 1929, 1931, 1935), the first records in eastern Asia, appear to have been the motivation for a survey of the family in China. Chao (1948) described three new species, *Terniopsis sessilis* H.C.Chao, *Lawiella chinensis* H. C. Chao, and *L. fukienensis* H. C. Chao (originally *fukiensis*), from Fujian. He redescribed *T. sessilis* in 1980 (Chao 1980) and placed the two species of *Lawiella* in the genus *Cladopus* (Chao 1982). *Cladopus nymanii s. lat.*, from Hainan, was added to the Chinese Podostemaceae by Chun & Tsiang (1963). Wu (1964) and Tao (1983) reported *Hydrobryum griffithii* (Wall. ex Griff.) Tul. from Yunnan and Cusset (1992) reported *C. nymanii s. lat.* from Hong Kong.

Terniopsis belongs to subfamily Tristichoideae, one of the three subfamilies of Podostemaceae, while *Cladopus* and *Hydrobryum* are assigned to subfamily Podostemoideae (Engler 1930, Kita & Kato 2001).

The Tristichoideae reach their northernmost limit of distribution in China (Fig. 1; Cusset & Cusset 1988, Kita & Kato 2001, Kato *et al.* 2003) and *Cladopus* and *Hydrobryum* in China are midway between the southeastern / southern and northern extremes of their range in Asia. The three species of *Cladopus* and four species of *Hydrobryum* in Japan represent the northernmost edge of the range of Podostemaceae in the Old World (Fig. 1).

In a comparative study of Chinese and Japanese species of Podostemaceae, Shin (1954) synonymized *Lawiella chinensis* under *L. kiusiana* Koidz. (= *C. japonicus* Imamura) and considered that *L. fukienensis* is probably conspecific with *L. doiana* Koidz. [= *C. doianus* (Koidz.) Koriba], pending further study. In the Flora of China, Wu (1988) recognized three genera and three species, synonymizing *Cladopus chinensis* and *C. fukienensis* under *C. nymanii* H. Möller. Although van Royen (1965) did not mention the Chinese species, Wu's treatment (Wu 1988) was based on van Royen's opinion that the Japanese *C. japonicus* and *C. doianus* are conspecific with *C. nymanii*, which

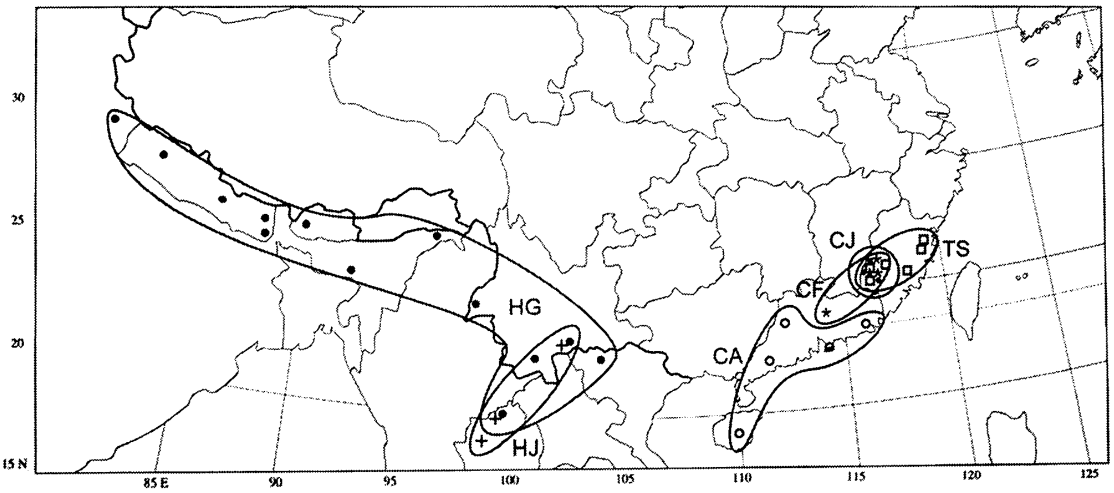

FIG. 1. Map showing distribution ranges of Chinese species of Podostemaceae. Open squares, *Terniopsis sessilis* (TS); small dots, *Cladopus japonicus* (CJ); asterisks, *Cladopus fukienensis* (CF); open circles, *Cladopus austrosinensis* (CA); solid circles, *Hydrobryum griffithii* (HG); crosses, *Hydrobryum japonicum* (HJ). Extra-Chinese specimens of *H. griffithii* are: *Pételot 3370*, near Sapa, Laocai, N Vietnam (Cusset 1973, Tao 1983); *Kato et al. TL418* (TI), Mae Fang Natl. Park, Chiang Mai, N Thailand; *Chattergee s.n.*, Ledo, Assam, NE India (Chatterjee 1947); *Griffith s.n.* (type), Khasi Hills, N India; *Kanai et al. 14456* (TI), Bhotokha–Rinchu, Bhutan; *Tuyama et al. s.n.* (TI), near Linkhim between Garhi Danra and Tuwa, Taplejung, E Nepal; *Kanai et al. 6301742* (TI), near Chyangthaphu, Illam, E Nepal; *Kanai 670543* (TI), N of Kathmandu, C Nepal; *Polunin et al. 5727*, W Nepal (Hara *et al.* 1982); *Naithani 42232*, N Garhwal, N India (Naithani 1971). Those of *H. japonicum* are: *Kato et al. TL415* (TI), Mae Fang Natl. Park, Chiang Mai, N Thailand; *Kato et al. TL426* (TI), Mae Pan Waterfall, Doi Inthanon, Chiang Mai, N Thailand. The distributions of *C. japonicus and H. japonicum* in Japan are not shown.

has consequently been recognized as a widely distributed and polymorphic species. In her taxonomic treatment of Podostemoideae (Podostemaceae in her sense) in Asia, Cusset (1992) also reduced *C. chinensis* and *C. fukienensis* to *C. nymanii* and reported *Hydrobryum griffithii* from China. Because of the different interpretation of the taxonomy of Podostemaceae in China, the family was in need of further investigation.

Our herbarium and field studies show that *Cladopus chinensis* is conspecific with *C. japonicus*, and it and *C. fukienensis* are distinct species and not conspecific with *C. nymanii*, partly supporting Chao's (1948, 1982) and Shin's (1954) classifications. Molecular data (Kita & Kato 2001, and unpubl. data) support the recognition of *C. japonicus* and *C. fukienensis*, plus a new species from China and one from Indonesia. The data also support segregating *Terniopsis* from *Dalzellia*, although *Terniopsis* was reduced to *Dalzellia* by Cusset & Cusset (1988; see note under *T. sessilis*). In this revision we recognize three genera and six species in China based on morphology and molecular analysis (Kita & Kato 2001, Y. Kita & M. Kato, unpubl. data).

The key below is more detailed than keys provided previously (Chao 1948, 1980, 1982, Wu 1964, 1988, Tao 1983, Cusset 1992). One new species is described. Herbarium abbreviations follow Holmgren *et al.* (1990), except for Fujian Normal University Herbarium, which is tentatively abbreviated as FNU.

Terniopsis H. C. Chao

Contr. Inst. Bot. Natl. Acad. Peiping 6: 2, 1948 (publ. 1949); Acta Bot. Yunnan. 2: 296, 1980; Fl. Fukien 1: 479, 1982; T.-L. Wu, Fl. Reipubl. Popularis Sin. 24: 1, 1988.

Dalzellia auct. non Wight: C. Cusset & G.

Key to the Chinese Species of Podostemaceae

1. Flowers borne along both sides of roots, 3-merous, with short leafy shoots and 2 entire opposite bracts; flower buds not covered by spathella; tepals 3, elliptic, alternate stamens, connate except for distal lobes; stamens 3; ovary locules 3, stigmas 3; capsules globose, 9-ribbed (ribs 3 per locule); roots compressed, subcylindrical; leaves borne on branches (ramuli), tristichous (one dorsal, two lateral-ventral), ovate, entire, vein 1 (subfam. Tristichoideae; *Terniopsis*) .... 1. *Terniopsis sessilis*

1. Flowers near sides or on dorsal surface of roots, 2-merous, with bracts digitate or entire, more than 4 in 2 rows; leafy shoots absent; flower buds enclosed by globose or ellipsoid spathella (special covering); tepals 2, linear, on both sides of stamens, free; stamens 1 or 2 (if 2, filaments forked); ovary locules 2, stigmas 2; capsules globose, smooth or ribbed (ribs 5 or 6 per locule); roots compressed, subcylindrical, ribbon-like or foliose; leaves borne on roots, fascicled, linear (subfam. Podostemoideae) ...2

 2. Stamen 1, simple; capsules globose, smooth, erect; bracts digitate, surface rough; roots compressed, subcylindrical or ribbon-like, with tufts of leaves along both sides of root (*Cladopus*) 3

  3. Roots 2.5 mm or more wide, ribbon-like, branching monopodially; bract bearing floral axes 3-4 mm long ....2. *Cladopus japonicus*

  3. Roots to 1(-1.3) mm wide, compressed, subcylindrical, branching sympodially; bract bearing floral axes 3-6 mm long 4

   4. Bract bearing floral axes 3.5-6 mm long; bracts 12-20 .... 3. *Cladopus fukienensis*

   4. Bract bearing floral axes ca. 3 mm long; bracts 10 or fewer........... 4. *Cladopus austrosinensis*

 2. Stamens 2, forked; capsules ellipsoid, compressed, ribbed, appressed to roots; bracts boat-shaped, entire; roots foliose, with tufts of linear leaves scattered over dorsal surface (*Hydrobryum*) 5

  5. Bracts 6; stigma subcristate, truncate or emarginate, not narrowed at apex; ovules borne over septa surface except in lower central area, 24-26 per locule; leaves 7-15 per tuft, 15-20 mm long .... 5. *Hydrobryum griffithii*

  5. Bracts 4(-6); stigma linear, entire, narrowed toward apex; ovules on margin of septa, 20 per locule; leaves 8-10 per tuft, 6-10 mm long .... 6. *Hydrobryum japonicum*

Cusset, Bull. Mus. Natl. Hist. Nat., B, Adansonia 10(2): 171, 1988, *p.p. Type species*: *Terniopsis sessilis* H. C. Chao.

Note: Chao (1948, 1980) considered that *Terniopsis* is most closely related to *Terniola* (= *Dalzellia*), and subsequently Cusset & Cusset (1988) placed it under *Dalzellia*. Wu (1988) argued that *Indotristicha* is referable to *Terniopsis*. The type species of *Dalzellia*, *D. zeylanica*, differs distinctly from *Terniopsis sessilis* and other species of subfamily Tristichoideae, particularly in that the main organ in *Dalzellia* has foliose shoots covered with minute leaves. Chao (1948, 1980) also noted the similarity of *Dalzellia* to *Tristicha*. Molecular phylogenetic data show that *Terniopsis* is most closely related to *Malaccotristicha* (Kita & Kato 2001). The clade of *Terniopsis* and *Malaccotristicha* is sister to the clade consisting of *Tristicha*, *Indotristicha* and *Dalzellia*. The relationship of *Terniopsis* and *Malaccotristicha* is supported by morphological similarities, e.g. subcylindrical roots with short leafy shoots on both sides, flower shoots associated with ramuli and two bracts at the base, shoots simple or rarely branched. In contrast to the distinct molecular differences (Kita & Kato 2001), *Terniopsis* differs from *Malaccotristicha* slightly in only a few characters, e.g. the ovate leaves (*vs.* triangular in *Malaccotristicha malayana*) and the axile placentation (*vs.* free central).

Terniopsis shows a disjunct distribution from *Malaccotristicha* and other genera of Tristichoideae, which, except for *Tristicha*, are distributed in southern India, Sri Lanka, peninsular Malaysia, Thailand, Laos, Cambodia and northwestern Australia (Cusset & Cusset 1988, Kato *et al.* 2003, M. Kato, unpubl. data). *Tristicha* occurs in Africa and South and Central America.

1. Terniopsis sessilis H. C. Chao, Contr. Inst. Bot. Natl. Acad. Peiping 6: 4, pl. 1, f. 1-15, 1948 (publ.1949); Acta Bot. Yunnan. 2: 297, pl. 1, f. 1-15, 1980; Fl. Fukien 1: 479, pl. 435, f. 1-10, 1982; T.-L. Wu, Fl. Reipubl. Popularis Sin. 24: 2, pl. 1, f. 1-4, 1988. –*Dalzellia sessilis* (H. C. Chao) C. Cusset & G. Cusset, Bull. Mus. Natl. Hist. Nat., B, Adansonia 10(2): 173, 1988. *Syntypes*: *H.-C. Chao 2285* (AU?), Nov. 19, 1944, Fujian, Changting, Shihlipu, Ting River; *H.-C. Chao 2298* (AU?, PE!), Dec. 13, 1945 (fl. buds), Fujian, Chotien, Choshui, a branch of the lower part of Ting River (specimens not found at AU, the location of the type specimens, and a search of them is needed before lectotypification).

Distribution: Southeast China (Fujian) (Fig. 1).

Habitat: On submerged rocks in rapids in open places. Roots dark red brown, some floating.

Other specimens examined: Fujian: *M. Kato CH-3* (FNU, TI), July 9, 2000 (st.), Ting River near Guangyinqiao, Datong, Changting, 25°51'N 116°23'E, 410 m alt.; *M. Kato CH-4* (FNU, TI), July 9, 2000 (st.), Ting River near Libifeng, Xingqiao, Changting, 25°51'N 116°25'E, 380 m alt.; *H.-C. Chao 2288* (PE), Jan. 20, 1945 (fl.), *H.-C. Chao s.n.* (IBSC), Fujian, Changting, Shihlipu, Ting River; *H.-C. Chao 2299* (FNU, KUN), June 3, 1948 (st.), Yunwei, Nan'an; *L.-G. Lin s.n.* (FNU), Aug. 1955, Huanxi north of Fuzhou.

Cladopus H. Möller

Ann. Jard. Bot. Buitenzorg, ser. 2, 16: 115, 1899; Engl., Nat. Pflanzenfam. 2nd ed. 18a: 50, 1930; Steenis, Fl. Males. Ser. 1, 4: 65, 1949; Backer & Bakhuisen van den Brink, Bekn. Fl. Java 1: 204, 1963; Ohwi, Fl. Jap. 394, 1965; C. Cusset, Fl. Cambodge, Laos & Viêt-nam 14: 71, 1973; Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 20, f. 1, 2, 1992; T.-L. Wu, Fl. Reipubl. Popularis Sin. 24: 4, 1988. *Type species*: *Cladopus nymanii* H. Möller.

Lawiella Koidz. in Doi, Florula Satsum. 1(2): 21, 1927; *emend.* Koidz. in Doi, Florula Satsum. 2: 94, 1931; Acta Phytotax. Geobot. 4: 23, 1935; H.-C. Chao, Contr. Inst. Bot. Natl. Acad. Peiping 6(1): 5, 1948 (publ. 1949). *Type species*: *Lawiella doiana* Koidz.

Hemidistichophyllum Koidz. in Doi, Florula Satsum. 1(3): 24, 1928. *Type species*: *Hemidistichophyllum japonicum* (Imamura) Koidz.

Lecomtea Koidz. in Doi, Florula Satsum. 1(4): 52, 1929. *Type species*: *Lecomtea pierrei* (Lecomte) Koidz.

Notes: Cusset (1992) delimited *Cladopus* in a broad sense in which she recognized two sections, *Cladopus* and *Griffithella*, the latter of which has been segregated as an distinct genus (Mathew & Satheesh 1997). In Cusset's (1992) classification, sect. *Cladopus* consists of two species, the widely distributed *C. nymanii s. lat.* and *C. taiensis* C. Cusset endemic to Thailand, while sect. *Griffithella* consists of *C. pierrei* (Lecomte) C. Cusset of Laos and Vietnam and *C. hookerianus* (Tul.) C. Cusset of southern India. Other authors (e.g. Ohwi 1965, Chao 1980, Kadono 1994, Kadono & Usui 1995) recognized two species (*C. chinensis*, *C. fukienensis*) from China and four (*C. austro-osumiensis*, *C. austrosatsumensis*, *C. doianus*, *C. japonicus*) from Japan. The Chinese species are endemic to Fujian Province, and the Japanese species are endemic to different small areas of southern Kyushu. By contrast, Shin (1954) treated *C. chinensis* as conspecific with *C. japonicus* and considered that *C. fukienensis* is probably conspecific with *C. doianus*. His treatment of *C. chinensis* is in accordance with this paper. Kato & Hambali (2001) described a new species, *C. javanicus* M. Kato & Hambali, from west Java. Cusset (1992) synonymized *C. fallax* C. Cusset of Thailand and Vietnam under *C. nymanii s. lat.*, but it may be another distinct species (M. Kato, unpubl. data).

Torrenticola queenslandica, from NE Queensland and SE New Guinea, was treated as *Cladopus queenslandicus* (Domin) C. D. K. Cook & Rutish. (Cook & Rutishauser 2001), and Kita & Kato (2001) found it to be nested within the *Cladopus* clade in a molecular phylogenetic tree, although the two genera differ considerably in vegetative and reproductive characters (Aston 1990). *Cladopus* may therefore consist of about 10 species, including the new species *C. austrosinensis*, described below. In molecular trees of section *Cladopus* (Kita & Kato 2001, Y. Kita & M. Kato, unpubl. data), there are two clades, one consisting of *C. nymanii s. str.*, *C. queenslandicus*, *C. javanicus*, and *C. taiensis*; and the other including the Chinese and Japanese species.

2. Cladopus japonicus Imamura, J. Jap. Bot. 5: 60, t. 1-3, f. 1-4, 1928; Bot. Mag. Tokyo 42: 379, pl. 5, 6, 1928; Ohwi, Fl. Jap. 394, 1965. –*Hemidistichophyllum japonicum* (Imamura) Koidz. in Doi, Florula Satsum. 1(3): 24, 1928. –*Lawiella kiusiana* Koidz., Fl. Symb. Orient. Asia. 96, 1930; in Doi, Florula Satsum. 2: 97, 1931; Shin, J. Jap. Bot. 29: 73, 1954. *Type*: *Imamura, Koriba & Miki s.n.*, Aug. 1927 (TI?, not seen), Sendai River, Kagoshima (Kyushu), Japan.

Lawiella austrosatsumensis Koidz. in Doi, Florula Satsum. 2: 101, 1931; Acta Phytotax. Geobot. 4: 26, 1935; Ohwi, Fl. Jap. 394, 1965; *syn. nov*. *Syntypes*: *Doi s.n.* June 1929, *Doi s.n.* Oct. 1929 (KYO?, not seen), Mawatari River, Kagoshima (Kyushu), Japan.

Lawiella chinensis H. C. Chao, Contr. Inst. Bot. Natl. Acad. Peiping 6: 4, pl. 3, f. 1-19, 1948 (publ. 1949). –*Cladopus chinensis* (H. C. Chao) H. C. Chao, Fl. Fukien 1: 481, pl. 437, f. 1-13, 1982. *Syntypes*: *H.-C. Chao 2289* (AU?), Jan. 21, 1945, *H.-C. Chao 2294* (AU?, IBSC!, KUN!, PE!), Nov. 15, 1945, Fujian, Changting Hsien, Hukou, Ting River; *H.-C. Chao 2295* (AU?, PE! as *2290*), Nov. 15, 1945, Fujian, Lipifeng, Ting River; *H.-C. Chao 2284* (AU?), Oct. 25, 1944, *H.-C. Chao 2287* (AU?), Nov. 20, 1944, *H.-C. Chao 2301* (AU?), Jan. 27, 1946, Fujian, Shihlipu, Ting River; *H.-C. Chao 2286* (AU?), Nov. 1944, Fujian, Changantein, Ting River; *H.-C. Chao 2297* (AU?), Dec. 13, 1945, Fujian, Chotien, Cho-shui (specimens not found at AU, a search for them is needed before lectotypification).

Cladopus nymanii auct. non H. Möller: T.-L. Wu in Fl. Reipubl. Popularis Sin. 24: 5, 1988; C. Cusset, Bull. Mus. Natl. Hist., B, Adansonia 14(1): 22, 1992, *p.p.*

Distribution: Southeast China (Fujian: Changting, Nan'an) and southern Japan (Kyushu) (Fig. 1).

Habitat: On submerged rocks in rapids in open places. Roots green.

Other specimens examined:Fujian: *M. Kato CH-2* (FNU, TI), July 8, 2000 (st.), Jiuxian River between Pengkou and Xinquan, 25°28'N 116°40'E, 430 m alt.; *M. Kato CH-5* (FNU, TI), July 9, 2000 (st.), Ting River near Libifeng, Xingqiao, Changting, 25°51'N 116°25'E, 380 m alt.; *H.-C. Chao 2300* (FNU), Yunwei, Nan'an, June 3, 1948 (fl.).

Notes: In detailed comparisons of the Chinese and Japanese species, Shin (1954) found considerable variation in the stigma, the number of lobes of the digitate bracts, and the length of the floral axis, and consequently no significant difference between *Cladopus chinensis* and *C. japonicus* (as *Lawiella kiusiana*). He concluded that the two species are conspecific. His treatment is supported by morphological and molecular data. The *matK* sequences are identical for them, *C. doianus* and *C. austro-*

satsumensis (Y. Kita & M. Kato, unpubl. data). *Cladopus japonicus* thus defined is not endemic to Japan, but disjunct between Fujian (China) and Kyushu (Japan).

Cladopus austrosatsumensis, which was considered to be endemic to southern Kyushu, is also conspecific with *C. japonicus*. The two species do not obviously differ in vegetative or floral characters. Although the leaves of *C. austrosatsumensis* are not deciduous and those of *C. japonicus* are deciduous (Koidzumi 1935), this inconspicuous difference may be ecological or local.

The systematic position of *Cladopus doianus*, another endemic to Japan, remains to be clarified. There is no difference in the *matK* sequence from *C. japonicus* (Y. Kita & M. Kato, unpubl. data). Morphologically, *C. doianus* differs from *C. japonicus* in the somewhat thinner (1-2 mm wide) roots and narrowly obovoid [4-8(-10) mm long] floral axes with the upper bracts larger than the lower, as in *C. fukienensis* and *C. austro-osumiensis*. *Cladopus doianus* shows remarkable teratological variation in the flowers (Doi 1929, Shin 1950).

Although *Cladopus japonicus*, like *C. fukienensis*, has been regarded as conspecific with *C. nymanii* (Cusset 1992), it is distinct from *C. nymanii* with its bract bearing floral axes to 10 mm long, stamens to 2.5 mm long and longer than the ovaries (*vs.* to 1.3 mm long and equaling or shorter than the ovaries in *C. japonicus*). *Cladopus japonicus* also differs from *C. fukienensis* by features used in the key.

3. Cladopus fukienensis (H. C. Chao) H. C. Chao, Fl. Fukien 1: 480, pl. 436, f. 1-13, 1982. –*Lawiella fukienensis* H. C. Chao, Contr. Inst. Bot. Natl. Acad. Peiping 6: 4, pl. 2, f. 1-21, 1948 (publ. 1949). *Syntypes*: *H.-C. Chao 2281* (AU?), Feb. 6, 1944, *H.-C. Chao 2282* (AU?, PE!), July 18, 1944, *H.-C. Chao 2283* (AU?, IBSC!, KUN!, PE!), Sept. 25, 1944 (fr.), *H.-C. Chao 2292* (AU?, FNU!, PE!), Oct. 30, 1945 (fl. & fr.), Fujian prov., Chanting, Lungmen, Ting River; *H.-C. Chao 2293* (AU?), Oct. 30, 1945, Fujian prov., Shijenshia, Ting River (specimens at AU not found, a search for them is needed before lectotypification).

Cladopus nymanii auct. non H. Möller: T.-L. Wu in Fl. Reipubl. Popularis Sin. 24: 5, 1988; C. Cusset, Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 22, 1992, *p.p.*

Distribution: Southeast China (probably central Guangdong and Fujian: N of Fuzhou, Changting) (Fig. 1). *Danert 1* (GAT, IBSC, Z) collected in Na-shih, 27 km NE of Conghua, 400 m alt., Guangdong (cited in Rutishauser 1997, f. 28, 39, 40), may be referable to this species.

Habitat: On seasonally submerged rocks in streams and rivers.

Other specimens examined: Fujian:*M. Kato CH-1* (FNU, TI), July 8, 2000 (st.), Buyun, Shanghan, 25°16'N 116°51'E, 865 m alt.; *L.-G. Lin s.n.* (FNU), Aug. 1955 (fl.), Huanxi north of Fuzhou.

Notes: *Cladopus fukienensis* is similar to *C. austro-osumiensis* in the narrow (up to 1 mm wide), subcylindrical roots with shoots near the sides of the root and rather long (up to 6 mm; to 8 mm in *C. austro-osumiensis*) bract - bearing floral axes. The close relationship of the two species is supported by molecular evidence (Y. Kita & M. Kato, unpubl. data). There are differences in a few characters, however. In *C. fukienensis* the stalk of the capsule is 1.3-3 mm long and extrudes from the spathella, while in *C. austro-osumiensis* the stalk of the capsule is 0.5-2 mm long and is often surrounded by the spathella in the lower half. The two species may be conspecific. If so, the earlier name is *C. fukienensis*.

4. Cladopus austrosinensis M. Kato & Y. Kita, **sp. nov**. (Figs. 2, 3)

Cladopus nymanii auct. non H.Möller: W.-Y. Chun & Y. Tsiang, Acta Phytotax. Sin. 8: 261, 1963, *p.p.*; T.-L. Wu, Fl. Hainan. 1: 373, f. 193, 1964, *p.p.*; C. Cusset, Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 22, 1992, *p.p.*

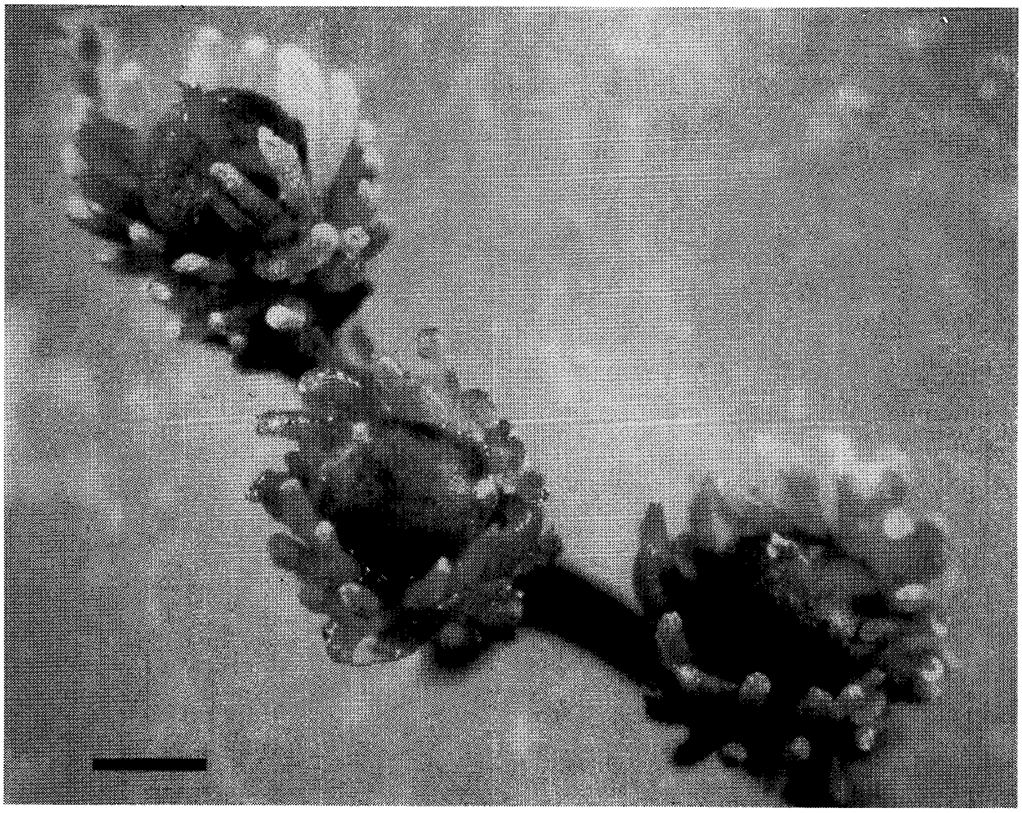

FIG. 2. *Cladopus austrosinensis* with three flower buds borne on root viewed from above (*Y.-F. Deng 16220*, isotype, TI). Scale bar = 1 mm.

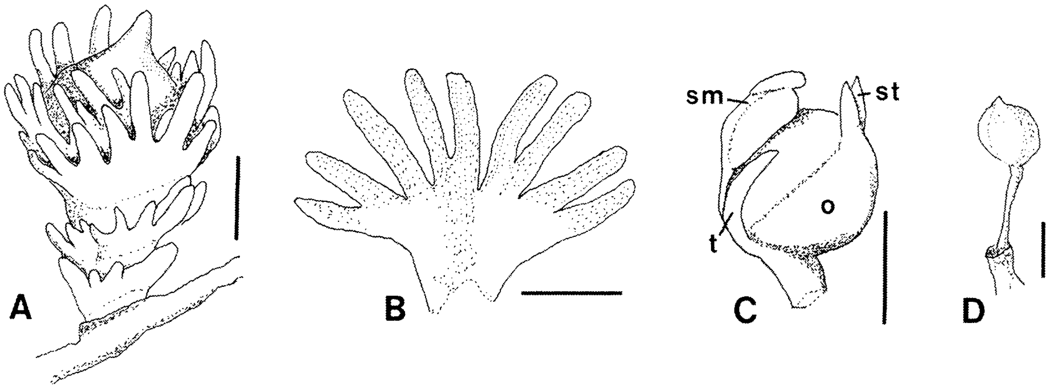

FIG. 3. *Cladopus austrosinensis* (*Y.-F. Deng 16220*, isotype, TI. Scale bar = 1 mm. A. Flower bud covered by mucronate spathella on bract bearing shoot. B. Bract. C. Young flower with spathella removed. D. Fruit. *o*, ovary; *sm*, stamen; *st*, stigma; *t*, tepal.

A *C. nymanii* et *C. chinensi* radicibus usque ad 1 mm latis, subcylindricis, a *C. fukiensi* bracteis usque ad 10, mucronibus spathellarum ca. 0.4 mm longis differt.

Type: CHINA, Hainan Is., Mt. Diaoluo, Lingshui Co., 18°42'N 109°50'E, 600 m alt., Nov. 22, 2001 (fl. & fr.). *Y.-F. Deng 16220* (holotype IBSC, isotype TI).

Roots creeping, adhering to rock surface, subcylindrical, compressed, branched, with branches on both sides of meandering main root, 0.5-1(-1.3) mm wide, with tufts of leaves near edge on both sides at every point of root branching; leaves to 5 per tuft, linear, flat, apex obtuse, to 6 mm long. Floriferous shoots to 3 mm long; bracts 8-10, in two rows, digitate; lobes 3-9, oblong or linear, to 0.7 mm x 0.3 mm, rough, with silica on surface, linear lobes to 5 mm long. Flowers at root nodes, solitary, upright, pedicellate, pedicel or stalk of ovary ca. 1.5 mm long, buds covered by spathella, spathella globose, apex mucronate, mucrones simple or sometimes forked, ca. 0.4 mm long, irregularly rupturing near apex at anthesis; tepals 2, on both sides of stamen, linear, 1-1.5 mm long; stamen 1, to 1.5 mm long, as long as ovary; ovary globose, ca. 1.5 mm long, ca. 1 mm thick, locules 2, with 2 nearly vertical grooves; stigmas 2, forked near base, ca. 0.6 mm long, equal, linear to subulate, entire, procumbent; ovules borne over septa surface, 25-34 per locule; septae convex in center, margins thin. Stalk of capsule to 1.7 mm long. Capsule, globose, 1.5 mm long, smooth (not ribbed), 2-valved.

Distribution: Southeast China (Guangdong, Hainan, Hong Kong) (Fig. 1).

Habitat: On rocks in rivers.

Other specimens examined:Guangdong: *Y.-F. Deng 16222* (IBSC, TI), Nov. 27, 2001 (fr.), Mt. Huang Zhang, Dianbai Co., 21°50'N 111°05'E, 500 m alt. Hainan: *Lin 15336* (IBSC), Dec. 12, 1954, Sanjiao-shan, Diaoluo-shan, Baoting, 500 m alt. Hong Kong: *Iwatsuki 63* (TI), Kowloon Peninsula, at the foot of Mt Tai Mo Shan, at 400-500 m alt., May 7, 1963 (fl. buds). Some other specimens are probably referable to this species: *B.-H. Chen 1582* (IBSC), Oct. 7, 1998, Huaiji, Guangdong prov.; *Huang & Zhang 78* (IBSC), Dec. 29, 1973, Puning, Guangdong prov.; *N.-H. Xia s.n.* (IBSC), Nov. 1, 2001, Dianbai Co., Guangdong prov.; *M. Gilbert et al. 267* (IBSC), Nov. 10, 2000, Baishuiling, Mt. Diaoluo, Lingshui Co., Hainan, 600 m alt. (H. Funakoshi, pers. comm., Y.-F. Deng, pers. comm.).

Notes: This species is distinctly different from *Cladopus nymanii* from Java in the narrow (to 1 mm wide *vs*. to 5 mm in *C. nymanii*), subcylindrical roots, shorter (to 3 mm long *vs*. 10 mm long) bract - bearing floral axes, and stamens as long as ovaries (*vs*. longer than ovaries) (see Kato & Hambali 2001). There are obvious differences from *C. japonicus* and *C. fukienensis* in particular in the root width and branching pattern, the length of the floral axes, and the number of bracts, as shown in key. Molecular analysis (Y. Kita & M. Kato, unpubl. data) shows that *C. austrosinensis* is most closely related to *C. fukienensis* and *C. austro-osumiensis*.

Hydrobryum Endl.

Gen. Pl. 1375, 1841, *p.p.*; Tul., Ann. Sci. Nat. ser. 3, 11: 103, 1849; Arch. Mus. Paris 6: 137, 1852; Hook. f., Fl. Brit. Ind. 5: 63, 1886; Willis, Ann. Roy. Bot. Gard. (Peradeniya) 1(3): 225, 1902; Engl., Nat. Pflanzenfam., 2nd ed. 18a: 52, 1930; Ohwi, Fl. Jap. 393, 1965; C. Cusset, Fl. Cambodge, Laos & Viêt-nam 14: 66, 1973; Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 44, 1992; D.-D. Tao, Acta Bot. Yunnan. 5: 175, 1983; T.-L. Wu, Fl. Reipubl. Popularis Sin. 24: 4, 1988. *Type species*: *Hydrobryum griffithii* (Wall. ex Griff.) Tul.

Hydroanzia Koidz., Acta Phytotax. Geobot. 4: 26, 1935. *Lectotype species*: *Hydroanzia floribunda* (Koidz.) Koidz. (here designated). *Hydroanzia floribunda* is selected as the lectotype species among three species cited because the description of the species corresponds most closely with the description of the genus, in particular in the perennial habit (Koidzumi 1935).

Notes: All species of *Hydrobryum*, plus *Zeylanidium olivaceum* (Gardner) Engl. and *Z. maheshwarii* C. J. Mathew & Satheesh, have foliose roots with tufts of leaves scattered over the dorsal surface of the root. The foliose roots are the most specialized transformation from the typical cylindrical root, and tufts of leaves on reduced, inconspicuous shoot are also extremely reduced shoots (Ota *et al*. 2001).

Of the approximately four non-Chinese species of *Hydrobryum*, *H. bifoliatum* C. Cusset is endemic to Thailand, and *H. floribundum* Koidz., *H. puncticulatum* Koidz., and *H. koribanum* Imamura ex Nakayama & Minamitani are endemic to Japan (Ohwi 1965, Kadono 1994, Nakayama & Minamitani 1999). There are some other undescribed, local, endemic species in Thailand (M. Kato, unpubl. data).

Koidzumi (1935) distinguished *Hydroanzia* from *Hydrobryum* by its perennial habit. However, plants of *Hydrobryum* and other genera may be annual or perennial according to where they grow. Plants exposed to air may become desiccated and die in dry seasons if they occur on upper rocks, but submerged plants may remain alive even in the dry season.

5. Hydrobryum griffithii (Wall. ex Griff.) Tul., Ann. Sci. Nat. Bot., ser. 3, 11: 103, 1849; C. Cusset, Fl. Cambodge, Laos & Viêt-nam 14: 68, pl. 10, f. 1-6, 1973; Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 45, 1992; D.-D. Tao, Acta Bot. Yunnan. 5: 175, pl. 1, f. 1-8, 1983; T.-L. Wu, Fl. Reipubl. Popularis Sin. 24: 4, pl. 1, f. 5, 1988. –*Podostemum griffithii* Wall. ex Griff., Asiat. Res. 19: 105, tab. 17, 1838. *Type*: *Griffith s.n.* (holotype K; isotype P; not seen), Khasi Hills, India.

Distribution: South-central China (southern and western Yunnan), Himalaya (Bhutan, N India, Nepal), N Thailand, N Vietnam (Fig. 1).

Habitat: On rocks in rivers in open places.

Specimens examined: Yunnan: *S.-K. Wu 943* (KUN, TI), Oct. 1995 (fr.), Qimaba, Luchun, 1100 m alt.; *Y. Kita & S.-K. Wu s.n.* (KUN, TI), Nov. 17, 2000 (fl. & fr.), Qimaba, Luchun, 22°51'N 102°11'E, 800 m alt.; *Luchun Bryophyte Expedition 398* (KUN), Oct. 1973, Luchun; *W.-X. Xu 003* (KUN), Mar. 19, 1957, highway 631 km point, Puwen, Xishuangbanna, 1450 m alt.; *Kunming Inst. Bot. Expedition 01088* (KUN), Nov. 19, 1986 (fr.), Naba, Shima, Yungjiang, 220 m alt.

Notes: *Hydrobryum griffithii* is the most widely distributed species in the genus. The oblong, subcristate stigmas of the Chinese plants are different from the cristate stigmas of the northern Indian and Thai populations, and are similar to an undescribed species from northern Thailand that is closely related to *H. griffithii* (M. Kato, unpubl. data). As in *H. griffithii*, however, the six bracts and the 26 ovules per locule are borne over the septa surface except on the lower central area. The leaves, to 20 mm long, are in tufts of 15.

Hydrobryum griffithii is known from northern Vietnam [Sapa (Chapa), Laocai], the closest to the Yunnan localities, and northern Thailand in Southeast Asia. Cusset (1973, pl. 10, f. 1-6) regarded a northern Vietnamese plant (*Pételot 3370*, P) with cristate stigmas to be *H. griffithii*. Although Tao (1983) considered the Yunnan plants to be the same as the Vietnamese plants, although Cusset (1992) later treated them as *H. japonicum*. Further taxonomic studies are needed.

6. Hydrobryum japonicum Imamura, Bot. Mag. Tokyo 42: 376, 1928; Bot. Mag. Tokyo 43: 332, 1929; Ohwi, Fl. Jap. 394, 1965; Shin, Wild Fl. Jap. Herb. Pl. 2: 214, 1982; C. Cusset, Bull. Mus. Natl. Hist. Nat., B, Adansonia 14(1): 46, 1992, *p.p.* – *Hydroanzia japonica* (Imamura) Koidz., Acta Phytotax. Geobot. 4: 28, 1935. *Type*: *Senokuchi s.n.* (TI?), Ohnejime, Kagoshima Pref. (Kyushu), Japan.

Distribution: South-central China (southern Yunnan), southern Japan (southern Kyushu), northern and central (Cusset 1992) Thailand (Fig. 1).

Habitat: On rocks in streams at forest edges.

Specimen examined: Yunnan: *Y. Kita & S.-K. Wu* (KUN, TI), Nov. 18, 2000 (fl. & fr.), Mayu stream between Luchun and Qimaba, 22°51'N 102°11'E.

Notes: This is the first report of *Hydrobryum japonicum* from China. The plants from Yunnan share the following with the Japanese and Thai populations of *H. japonicum*: stigmas linear, entire, with pointed apex; ovules 18-20 per locule, borne in a whorl on the margin of the ovary septum; leaves 5-10 per tuft, 3-10 mm long (Cusset 1992, Nakayama

& Minamitani 1999). In those and other characters *H. japonicum* differs from *H. griffithii*, as shown in the key. Molecular analyses including Chinese materials show that the two species are in two distinct clades (Kita & Kato 2001, Y. Kita & M. Kato, unpubl. data).

We thank S.-K. Wu, S.-J. Lin, J.-Q. Liu, and B.-H. Chen for their help on collecting trips, T.-L. Wu and Y.-F. Deng for collecting materials from Hainan and Guangdong, H. Funakoshi and Y.-F. Deng for their help in examining specimens at IBSC, and the directors of the herbaria KUN, KYO, PE, TI and Fujian Normal University for allowing us to access to their specimens. We are also indebted to D. E. Boufford and an anonymous reviewer for their useful comments and suggestions. This study was supported in part by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science.

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Received April 21, 2003, accepted July 21, 2003